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(54) **METERING FOR DISPLAY MODES IN ARTIFICIAL REALITY**

(71) Applicant: **Facebook Technologies, LLC**, Menlo Park, CA (US)

(72) Inventors: **James Tichenor**, Seattle, WA (US); **Hayden Schoen**, Tacoma, WA (US); **Yeliz Karadayi**, Seattle, WA (US)

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G02B 27/01	(2006.01)
H04N 13/00	(2018.01)

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CPC ***H04N 13/122*** (2018.05); ***G02B 27/0172*** (2013.01); ***H04N 13/332*** (2018.05); *G02B 2027/014* (2013.01); *H04N 2013/0081* (2013.01)

(58) **Field of Classification Search**
CPC H04N 13/122; H04N 13/332; H04N 2013/0081; G02B 27/0172; G02B 2027/014
See application file for complete search history.

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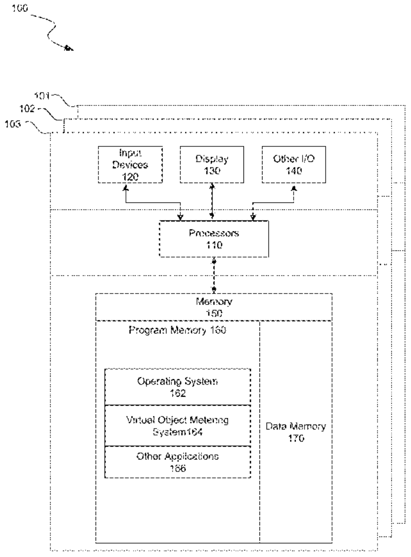
Primary Examiner — Jitesh Patel
(74) *Attorney, Agent, or Firm* — Potomac Law Group, PLLC

(57) **ABSTRACT**

Aspects of the present disclosure are directed to setting a display mode for a virtual object based on a display mode timer that is controlled by context factors. An artificial reality system can associate one or more virtual objects with a corresponding display mode timer. Various ranges on the display mode timer can be mapped to different display modes that the virtual object can assume. The display mode timer can be adjusted to add time based on a determination of a user focusing on the virtual object or other context factors. Display mode timers can also have rules for setting other display mode timer properties, such as how quickly the display mode timer runs down, that are evaluated based on context factors.

20 Claims, 13 Drawing Sheets



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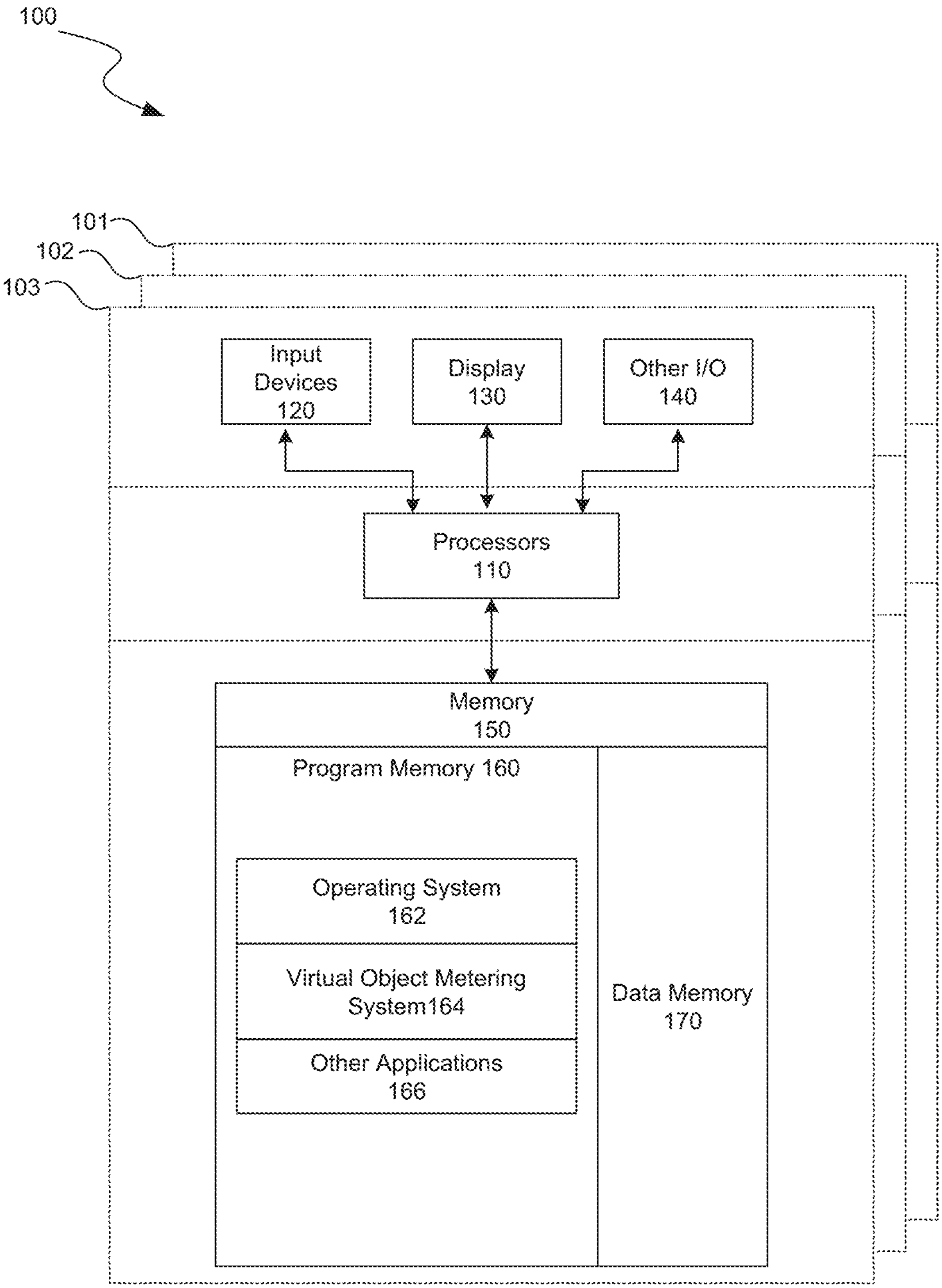
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101
102
103
Input Devices 120
Display 130
Other I/O 140
Processors 110
Memory 150
Program Memory 160
Operating System 162
Virtual Object Metering System164
Other Applications 166
Data Memory 170

FIG. 1

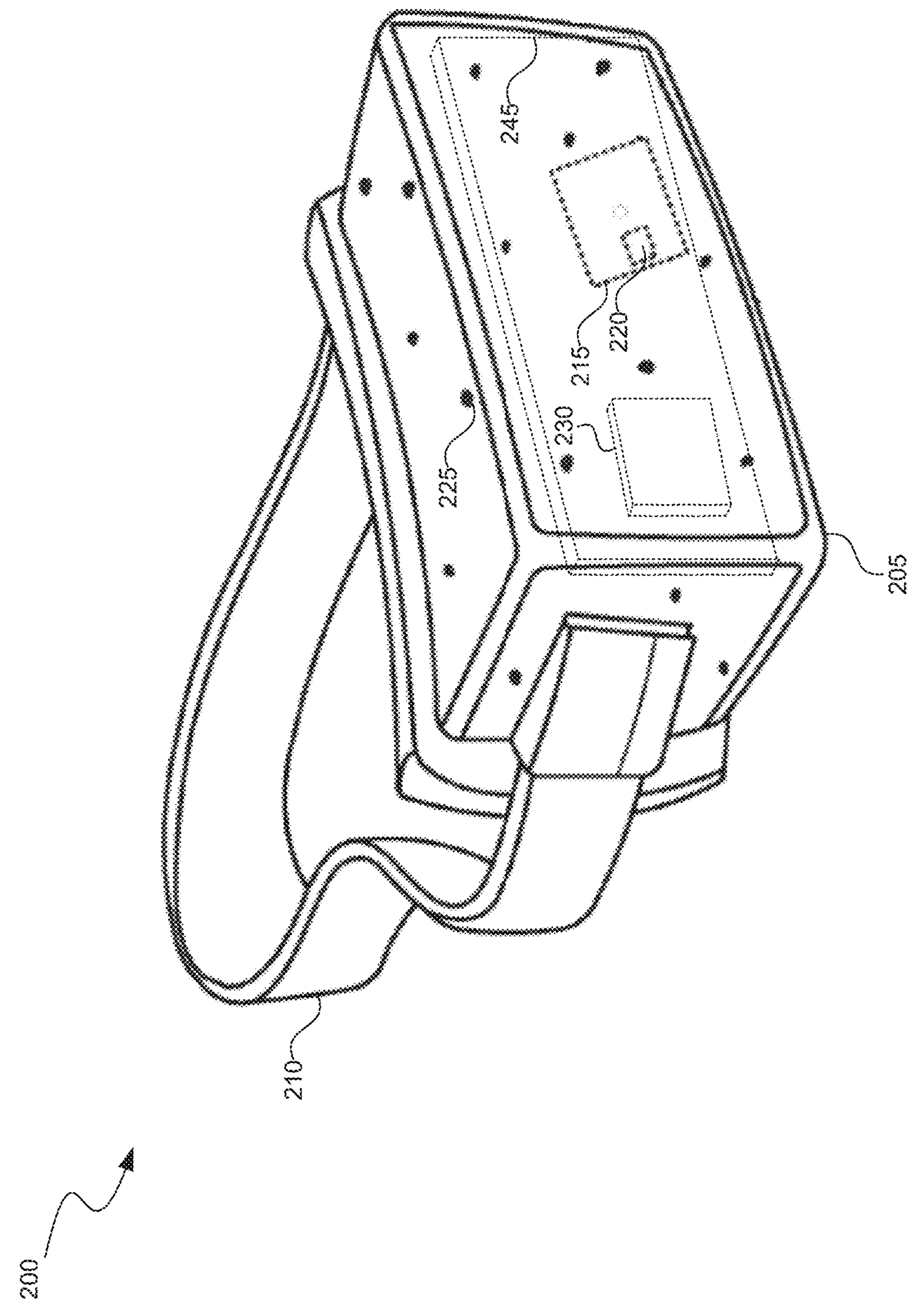


FIG. 2A

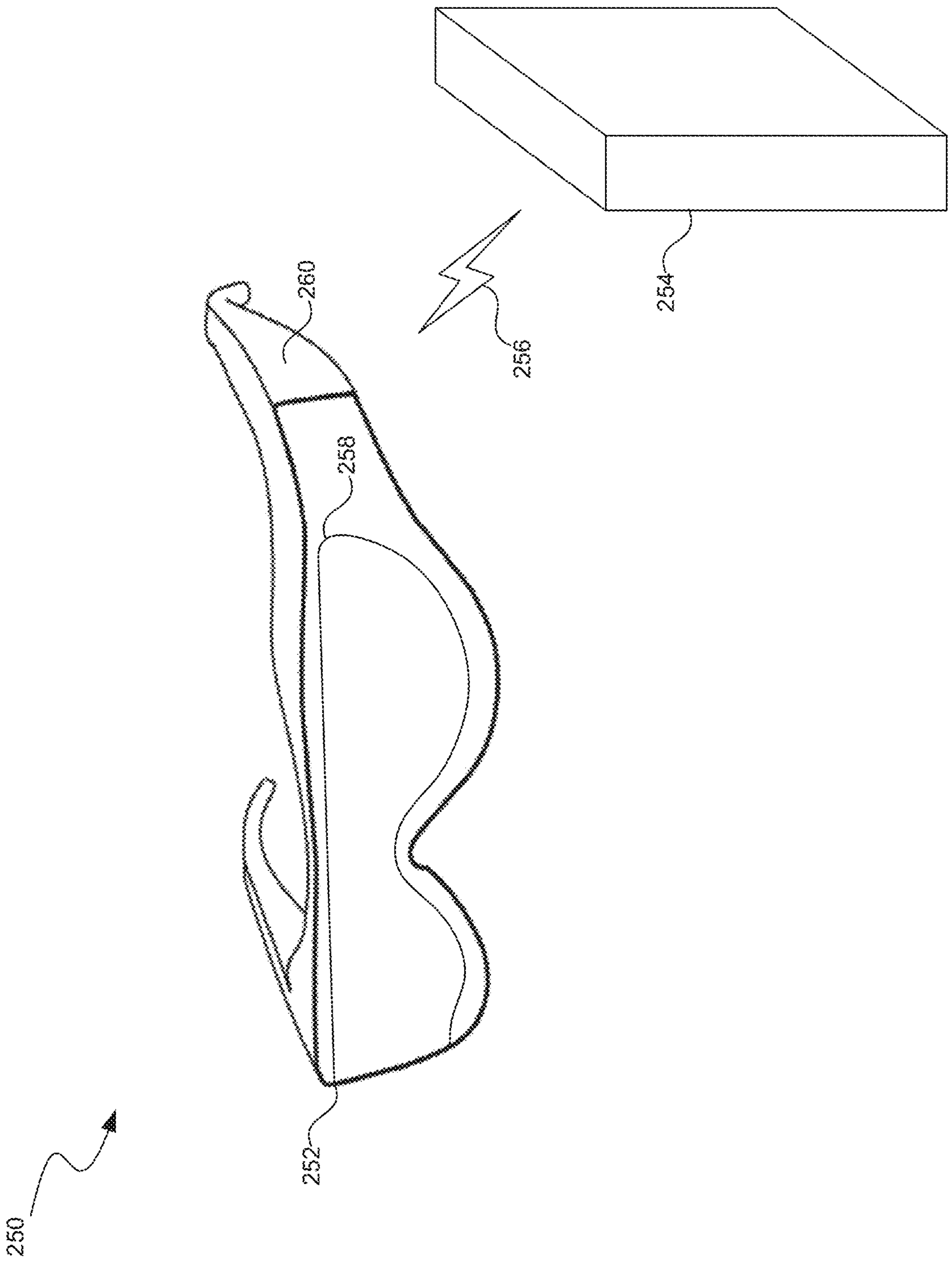


FIG. 2B

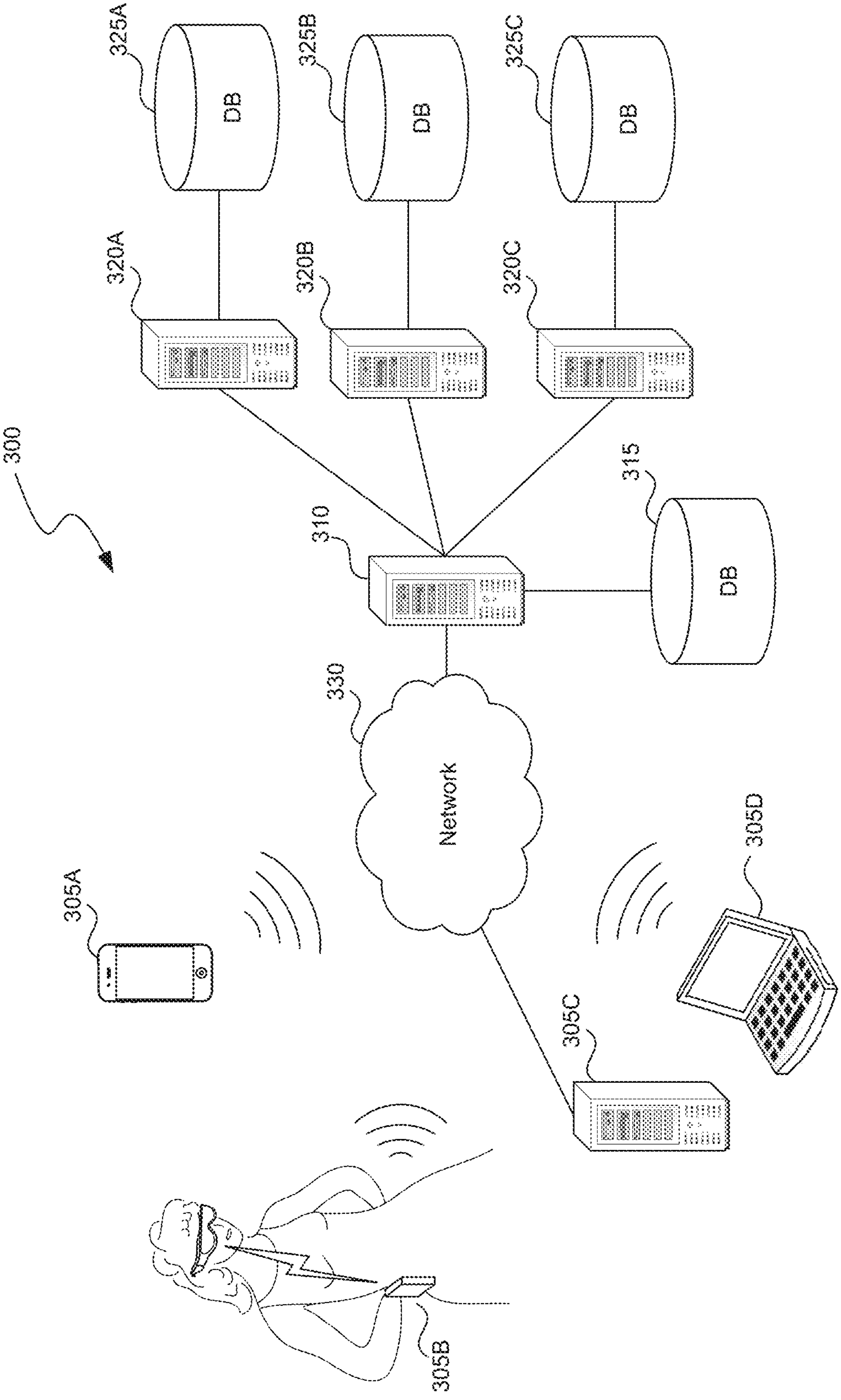

300
325A
DB
325B
DB
325C
DB
320A
320B
320C
310
315
DB
330
Network
305A
305B
305C
305D

FIG. 3

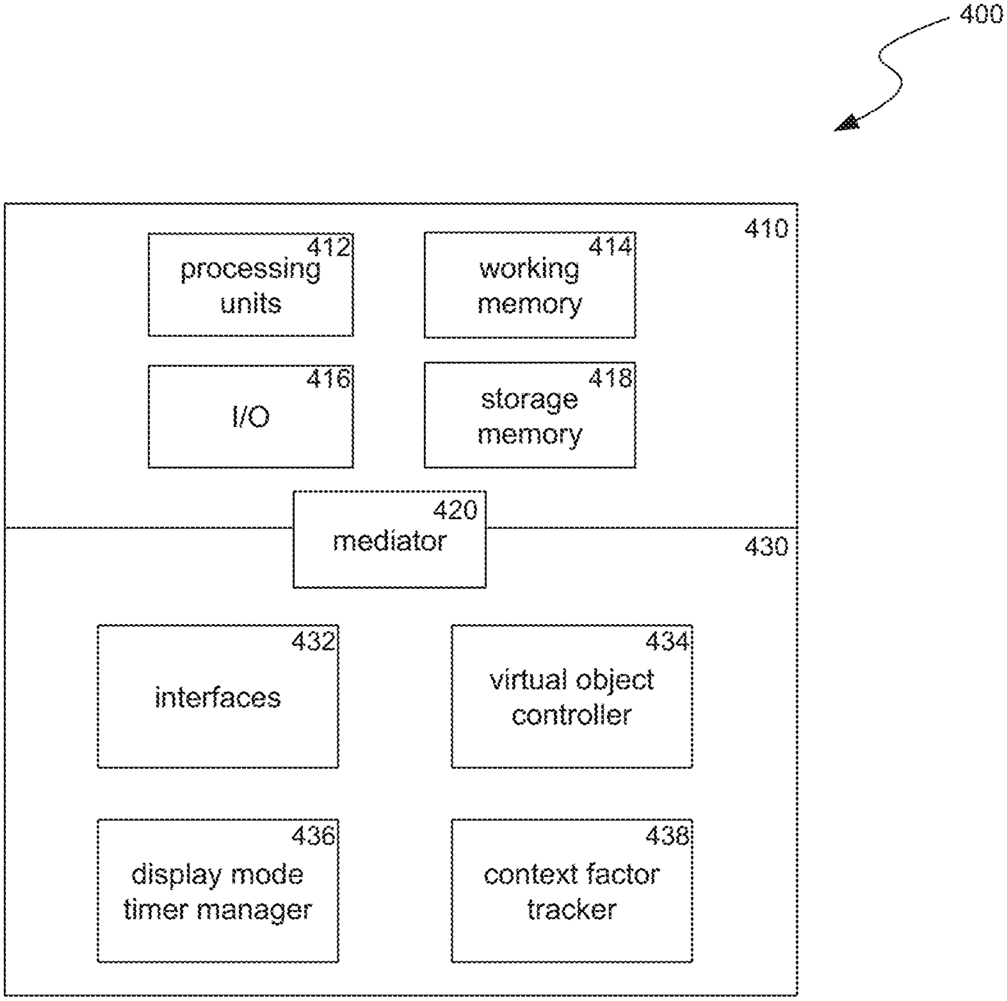

400
410
412
processing units
414
working memory
416
I/O
418
storage memory
420
mediator
430
432
interfaces
434
virtual object controller
436
display mode timer manager
438
context factor tracker

FIG. 4

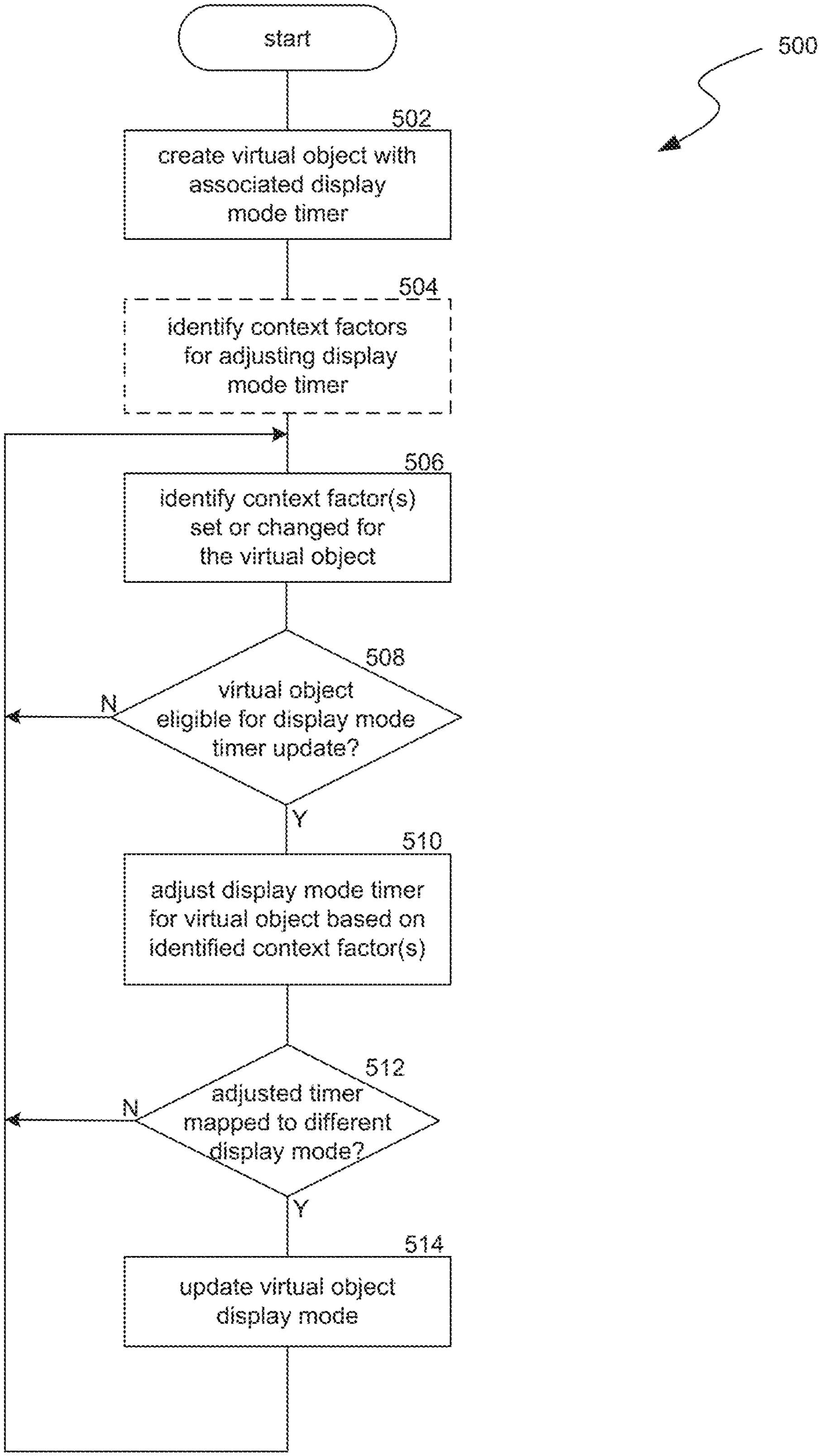

500
start
502
create virtual object with associated display mode timer
504
identify context factors for adjusting display mode timer
506
identify context factor(s) set or changed for the virtual object
508
virtual object eligible for display mode timer update?
N
Y
510
adjust display mode timer for virtual object based on identified context factor(s)
512
adjusted timer mapped to different display mode?
N
Y
514
update virtual object display mode

FIG. 5

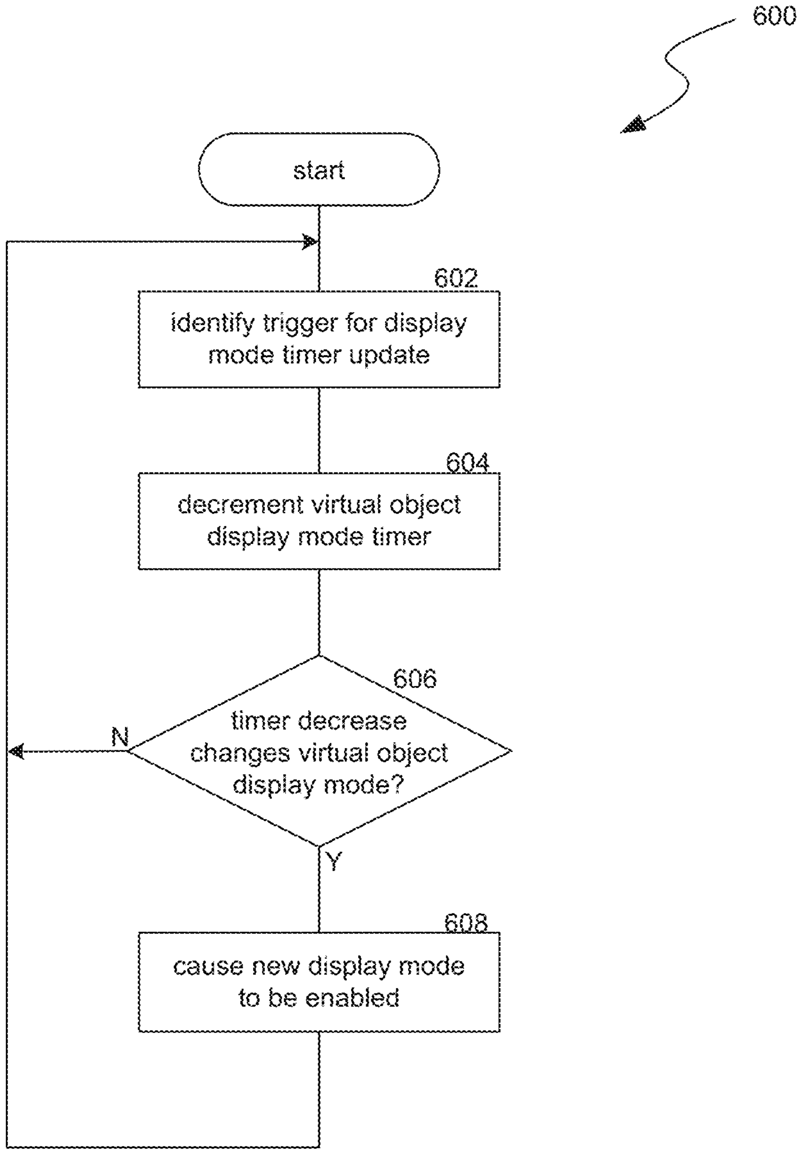

600
start
602
identify trigger for display mode timer update
604
decrement virtual object display mode timer
606
timer decrease changes virtual object display mode?
N
Y
608
cause new display mode to be enabled

FIG. 6

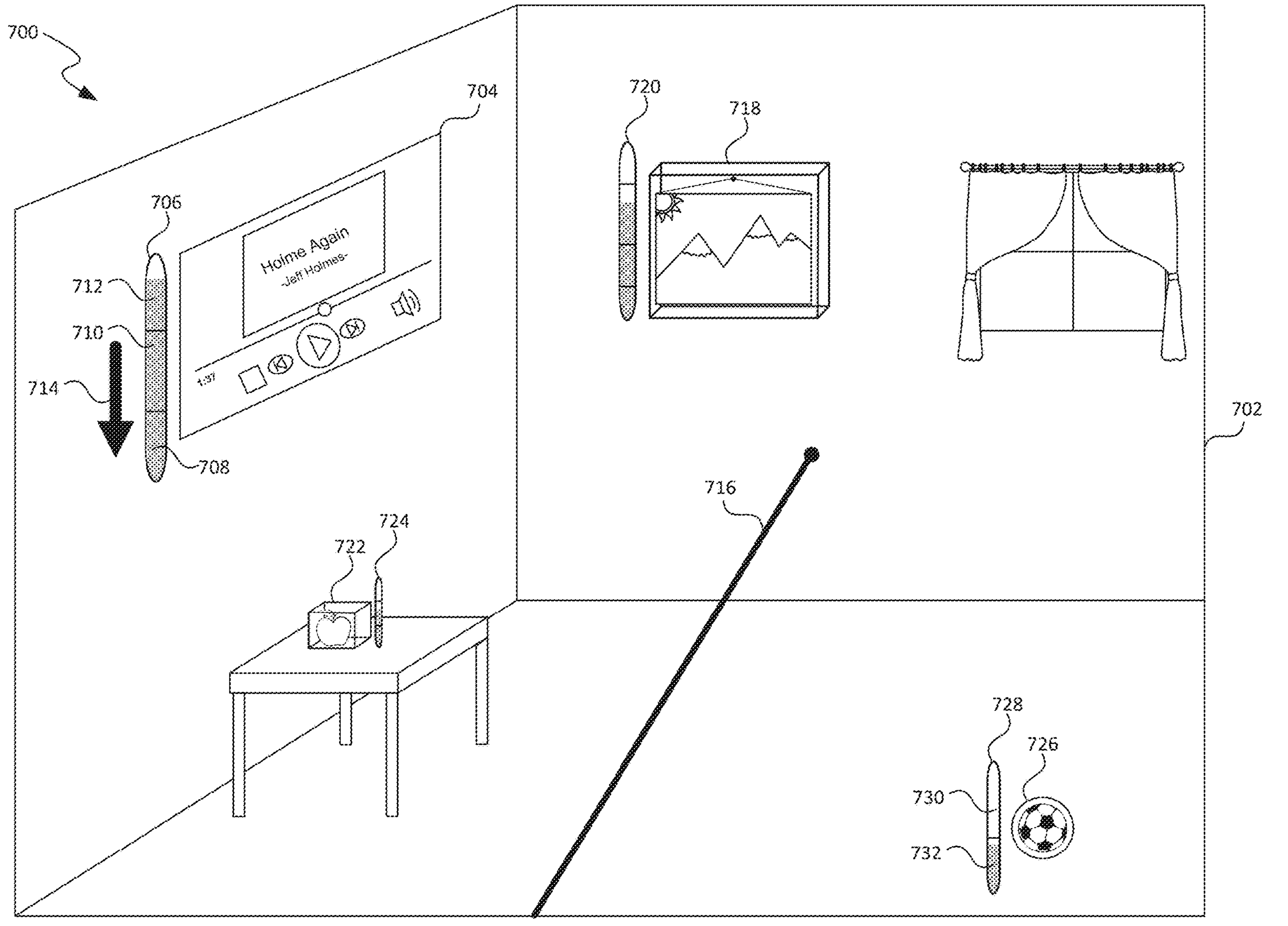
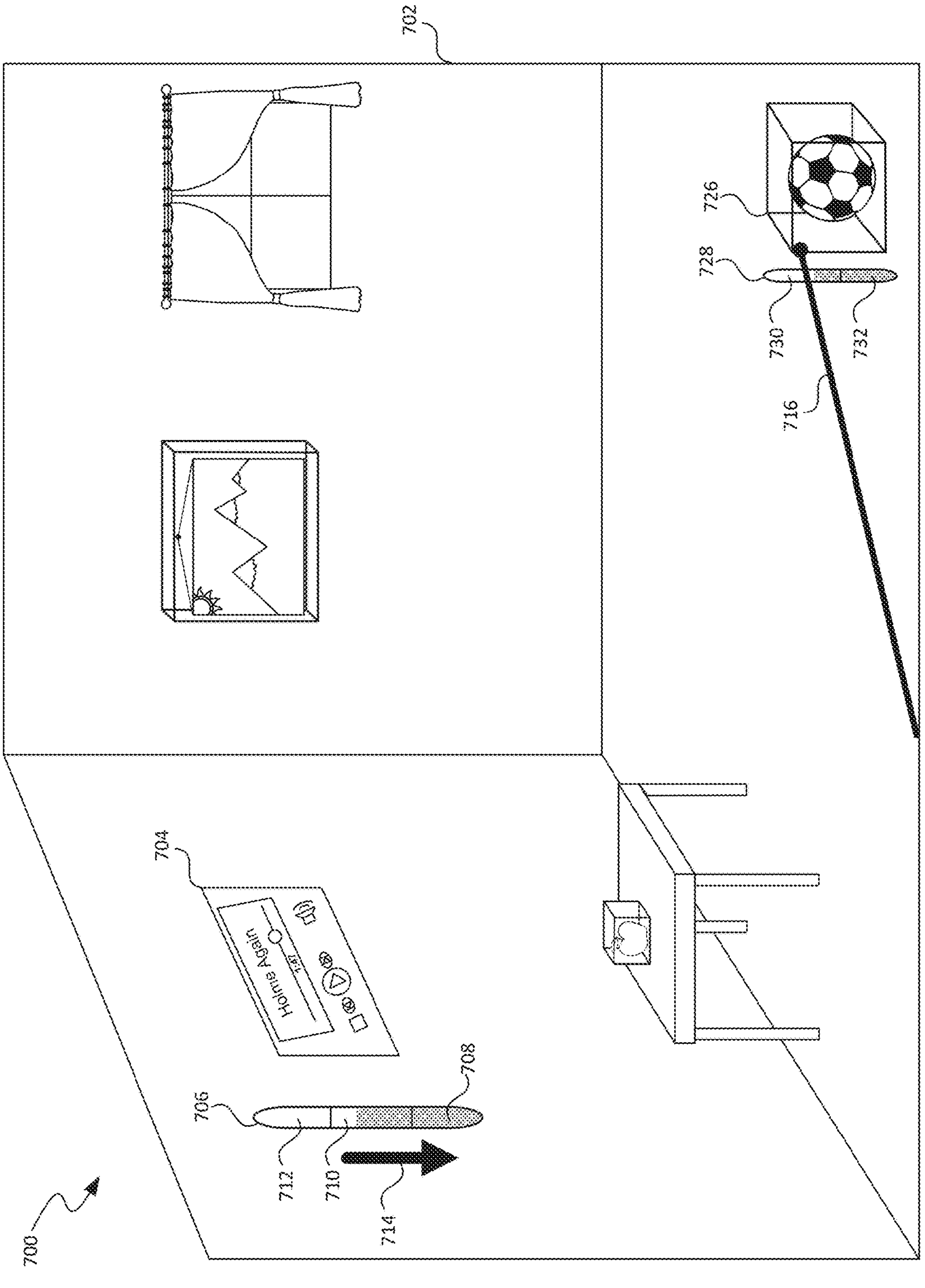

700
704
706
712
710
714
708
Holme Again
-Jeff Holmes-
1:37
720
718
702
716
722
724
728
726
730
732

FIG. 7A


700
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Holmis Again
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706
708
710
712
714
716
726
728
730
732

FIG. 7B

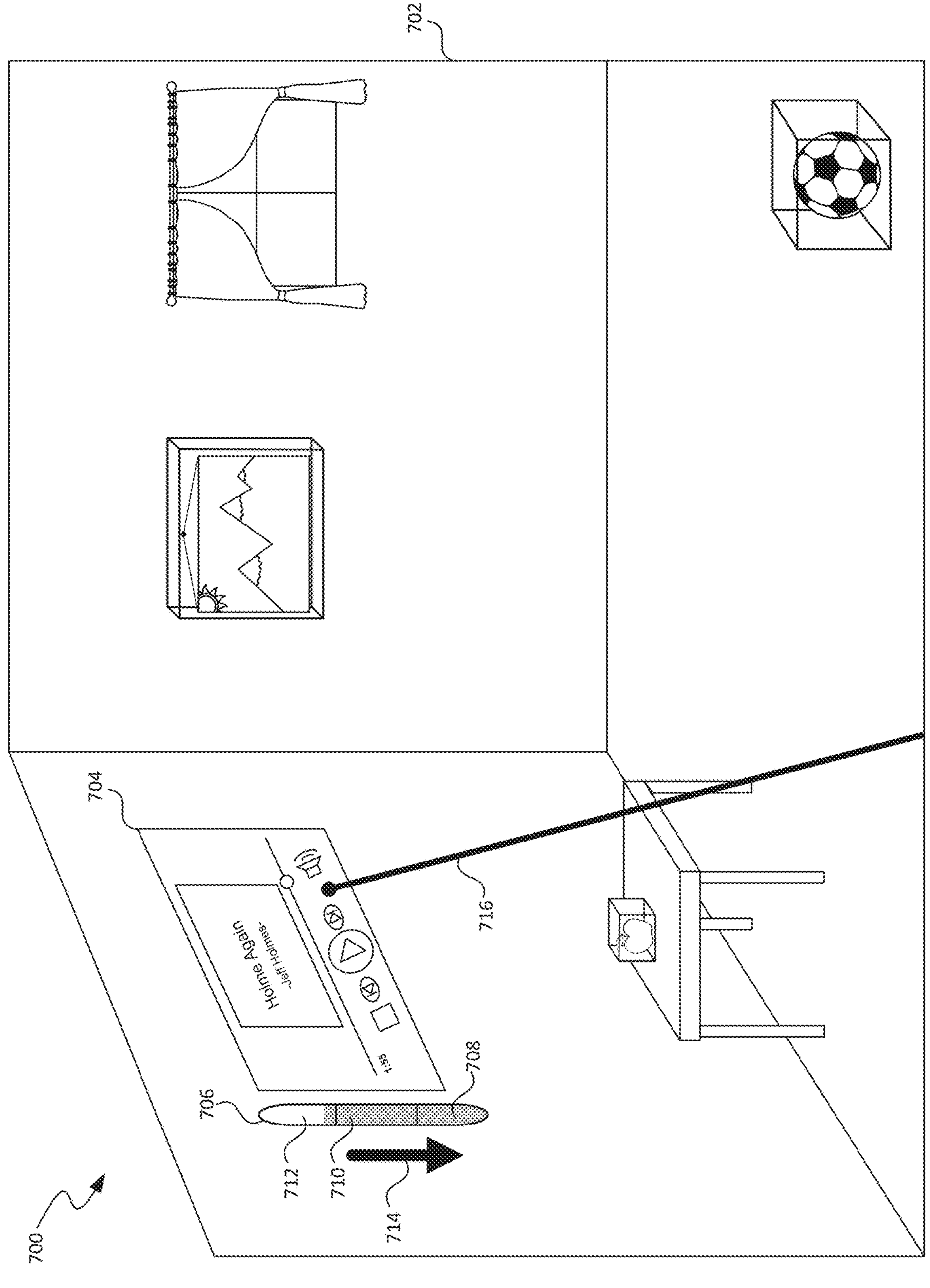
700
702
704
706
708
710
712
714
716
Holme Again
-Jeff Holmes-
1:55

FIG. 7C

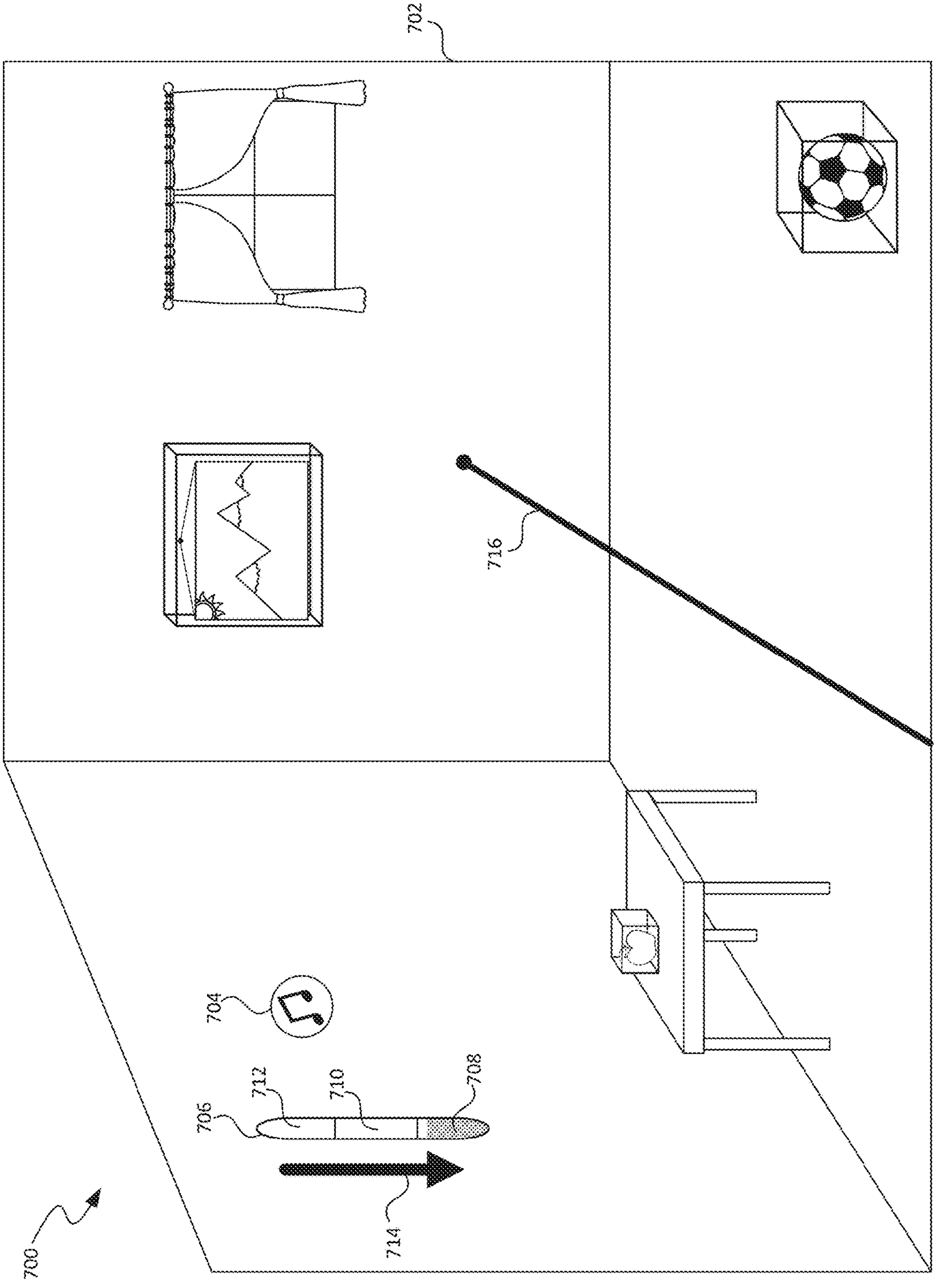

FIG. 7D

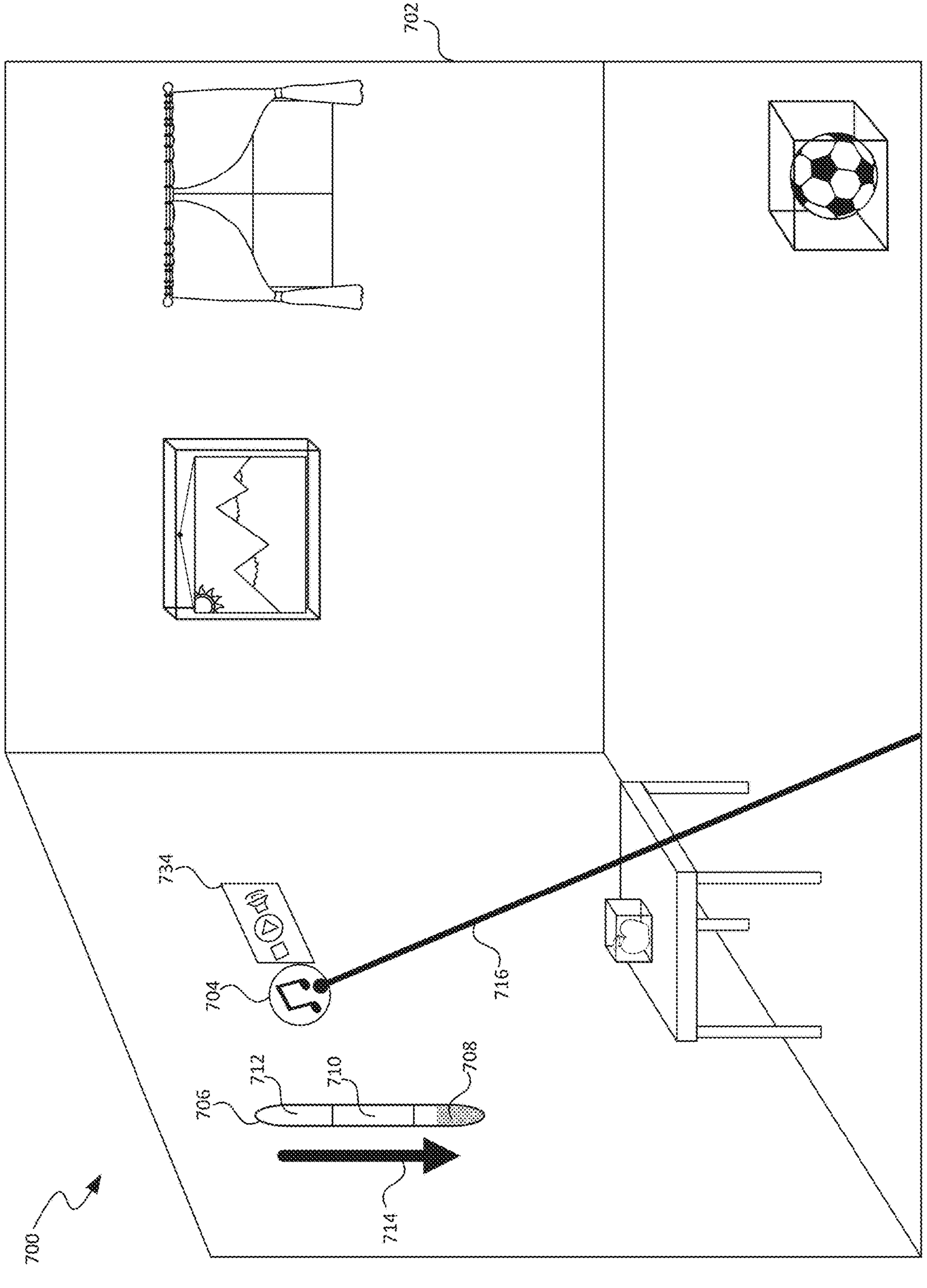

FIG. 7E

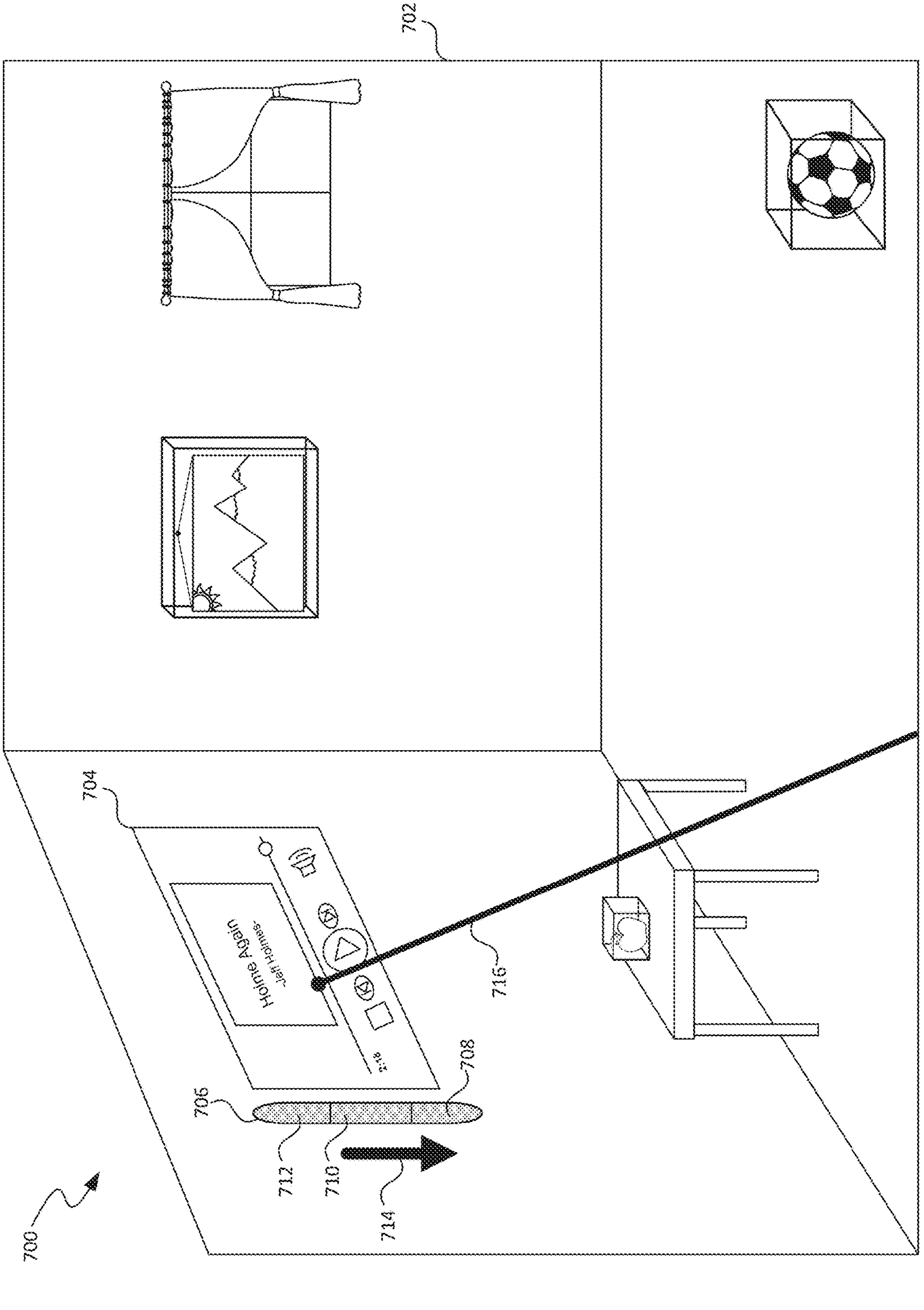
700
702
704
Holme Again
-Jeff Holmes-
2:18
706
708
710
712
714
716

FIG. 7F

METERING FOR DISPLAY MODES IN ARTIFICIAL REALITY

TECHNICAL FIELD

The present disclosure is directed to setting display modes for virtual objects, in an artificial reality environment, based on a display mode timer.

BACKGROUND

In an artificial reality environment, some or all of the objects a user sees and interacts with are "virtual objects," i.e., representations of objects generated by a computing system that appear in an environment. Virtual objects in an artificial reality environment can be presented to the user by a head-mounted display, a mobile device, a projection system, or another computing system. Often, users can interact with virtual objects using controllers and/or gestures. For example, user "interactions" with virtual objects can include selecting, moving, rotating, resizing, actuating controls, changing colors or skins, defining interactions between real or virtual objects, setting virtual forces to act on virtual objects, or any other action on or change to an object that a user can imagine. Virtual objects can be 3D models, 2D panels, representations of user avatars, interfaces to control applications, collections of other virtual objects, etc. In some systems, a user can also interact with "real objects" that exist independent of the computer system that is controlling the artificial reality environment. For example, a user can select a real object and add a virtual overlay to change the object's color or some other way the object is presented to the user, cause the real object to affect other virtual objects, etc. As used herein, unless otherwise specified, an "object" can be a real or virtual object.

Virtual objects in an artificial reality environment can have various display properties such as size, shape, opacity, coloring, etc., which can be set when the object is created. In some cases, these display properties can change during the life of the object. However, such changes can be disorienting to a user when they are unexpected or performed for a virtual object on which a user is currently focused.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram illustrating an overview of devices on which some implementations of the present technology can operate.

FIG. **2**A is a wire diagram illustrating a virtual reality headset which can be used in some implementations of the present technology.

FIG. **2**B is a wire diagram illustrating a mixed reality headset which can be used in some implementations of the present technology.

FIG. **3** is a block diagram illustrating an overview of an environment in which some implementations of the present technology can operate.

FIG. **4** is a block diagram illustrating components which, in some implementations, can be used in a system employing the disclosed technology.

FIG. **5** is a flow diagram illustrating a process used in some implementations of the present technology for creating a virtual object with a display mode timer and adjusting the display mode timer in response to context factors.

FIG. **6** is a flow diagram illustrating a process used in some implementations of the present technology for decrementing a display mode timer of a virtual object and setting a display mode for the virtual object according to the display mode timer.

FIG. **7**A is a conceptual diagram illustrating an example virtual object, in a maximized display mode, with a display mode timer controlled by user gaze and power level context factors.

FIG. **7**B is a conceptual diagram illustrating the example virtual object with the display mode timer decreased to a level causing a change to a minimized display mode.

FIG. **7**C is a conceptual diagram illustrating the example virtual object with the display mode timer increased based on a user gaze directed at the virtual object, causing a change back to the maximized display mode.

FIG. **7**D is a conceptual diagram illustrating the example virtual object with the rate at which the display mode timer decrements increased, and the display mode timer decreased to a level causing a change to a glint display mode.

FIG. **7**E is a conceptual diagram illustrating the example virtual object remaining in the glint mode while adding key actions in response to the user gaze being again directed at the virtual object.

FIG. **7**F is a conceptual diagram illustrating the example virtual object returning to maximized mode in response to a user maximization gesture while the user gaze is directed at the virtual object.

The techniques introduced here may be better understood by referring to the following Detailed Description in conjunction with the accompanying drawings, in which like reference numerals indicate identical or functionally similar elements.

DETAILED DESCRIPTION

Aspects of the present disclosure are directed to setting a display mode for a virtual object based on a display mode timer that is controlled by context factors. When an artificial reality system presents virtual objects in an artificial reality environment, if the objects are always in a fully maximized display mode, they can overwhelm the user's field of view (FOV) and can consume significant power and processing resources. However, requiring manual actions to transition virtual objects to a minimized display mode would be frustrating and overly time-consuming for users. Instead, an artificial reality system configured in accordance with the present technology can associate one or more virtual objects with a corresponding display mode timer. Various ranges on the display mode timer can be mapped to different display modes that the virtual object can assume. For example, a display mode timer for a virtual object containing models for a geographical mapping application can be initially set to 30 seconds with ranges 15-30 seconds corresponding to a display mode that displays all the models, 5-14 seconds corresponding to a minimized mode which reduces the size of the models and removes models providing details, and 0-4 seconds corresponding to a "glint" mode which only shows a small icon for the mapping application. In various implementations, display mode timers can all have the same range mappings or different display mode timers can have different range mappings.

In some cases, the display mode timer can be adjusted to add time based on a determination of a user focusing on the corresponding virtual object. In various implementations, this focus can be identified based on a determined gaze of the user being directed at the virtual object, the user providing input (e.g., a selection gesture, a voice command, etc.) in relation to the virtual object, the user moving to within a threshold distance, in the artificial reality environment, of the virtual object, etc. Such a determination of user focus is one type of context factor that an artificial reality system can monitor. In some implementations, additional or other types of context factors can be the basis for adding or removing time from a display mode timer. For example, time can be added to a display mode timer when data is provided in relation to the corresponding virtual object, when that virtual object is providing "active output" (i.e., playing music or a video, displaying live data, providing a notification, or otherwise providing output of a type defined for preventing a change in display modes), or when the artificial reality system changes to a different state (e.g., from power saving mode to normal mode). In addition to an amount of time on a display mode timer, display mode timers can have other properties such as a maximum amount of time or how quickly the display mode timer runs down. While display mode timers are referred to herein as having "time," a countdown speed property of a display mode timer can decrement that allocated time faster or slower than a normal clock. For example, a countdown speed of a display mode timer can cause the time to run out more quickly when a virtual object is not displayed relative to a user, based on how much display space (and therefore power) a virtual object is taking (e.g., in relation to various thresholds), when an artificial reality system is in power saving mode, when a virtual object is further away (above a threshold amount) from a user, etc.

When the time remaining on a display mode timer crosses a boundary to a range corresponding to a new display mode, the corresponding virtual object can be triggered to enable the new display mode. In some implementations, certain display mode timer ranges can specify constraints defining how the virtual object can write to the display (e.g., how much of the display it can use, where it can be placed, how often it can wake up, etc.).

In some implementations, display modes or constraints can apply to only some aspects of a virtual object. For example, display modes or constraints can control visual or audio output separately. In some cases, once a virtual object has reached a certain display mode, such as a glint mode, it may take a specified user action (e.g., a particular gesture) to add time back onto the corresponding display mode timer. In some implementations, virtual objects may be grouped (e.g., based on type of data they work on, user grouping selections, etc.) so that they share a display mode timer or so that the display mode timers assigned to them are synchronized.

Embodiments of the disclosed technology may include or be implemented in conjunction with an artificial reality system. Artificial reality or extra reality (XR) is a form of reality that has been adjusted in some manner before presentation to a user, which may include, e.g., virtual reality (VR), augmented reality (AR), mixed reality (MR), hybrid reality, or some combination and/or derivatives thereof. Artificial reality content may include completely generated content or generated content combined with captured content (e.g., real-world photographs). The artificial reality content may include video, audio, haptic feedback, or some combination thereof, any of which may be presented in a single channel or in multiple channels (such as stereo video that produces a three-dimensional effect to the viewer). Additionally, in some embodiments, artificial reality may be associated with applications, products, accessories, services, or some combination thereof, that are, e.g., used to create content in an artificial reality and/or used in (e.g., perform activities in) an artificial reality. The artificial reality system that provides the artificial reality content may be implemented on various platforms, including a head-mounted display (HMD) connected to a host computer system, a standalone HMD, a mobile device or computing system, a "cave" environment or other projection system, or any other hardware platform capable of providing artificial reality content to one or more viewers.

"Virtual reality" or "VR," as used herein, refers to an immersive experience where a user's visual input is controlled by a computing system. "Augmented reality" or "AR" refers to systems where a user views images of the real world after they have passed through a computing system. For example, a tablet with a camera on the back can capture images of the real world and then display the images on the screen on the opposite side of the tablet from the camera. The tablet can process and adjust or "augment" the images as they pass through the system, such as by adding virtual objects. "Mixed reality" or "MR" refers to systems where light entering a user's eye is partially generated by a computing system and partially composes light reflected off objects in the real world. For example, a MR headset could be shaped as a pair of glasses with a pass-through display, which allows light from the real world to pass through a waveguide that simultaneously emits light from a projector in the MR headset, allowing the MR headset to present virtual objects intermixed with the real objects the user can see. "Artificial reality," "extra reality," or "XR," as used herein, refers to any of VR, AR, MR, or any combination or hybrid thereof.

Existing artificial reality systems either fail to provide virtual objects that have varying display modes or only provide display mode transitions that require excessive user instruction and/or are disruptive to user experiences. An artificial reality system that presents virtual objects in a single display mode can cause the virtual objects to overwhelm the user's field of view, while also consuming significant power and processing resources. Further, artificial reality systems that require manual user actions to transition virtual objects between display modes are frustrating and overly time consuming for users. Yet other artificial reality systems that may have rules for transitioning between display modes fail to implement them in a manner that users find intuitive, which can cause frustration when a virtual object unexpectedly minimizes and/or wastes power when a display renders a virtual object the user is not focused on.

The artificial reality system and processes described herein are expected to overcome these problems associated with existing artificial reality systems by 1) decreasing cognitive load on users by generally not requiring manual virtual object minimizations; 2) increasing system usability by reserving the user's FOV for virtual objects that the user is interested in; and 3) saving power and processing resources by reducing the amount of display space and rendering used by virtual objects that are not of interest to the user. Each of these benefits can be achieved by applying a display mode timer to virtual objects, where ranges of the display mode timer are mapped to display modes and time and can be added to the display mode timer based on user focus and/or other context factors. Further, the systems and processes described herein are rooted in computerized artificial reality systems, instead of being an analog of traditional content interactions. For example, when displaying content, existing computing systems may resize and change styles to fit the content to the viewing area (e.g., reactive display in a website) but do not change and update display modes based on timers controlled by user focus.

Several implementations are discussed below in more detail in reference to the figures. FIG. **1** is a block diagram illustrating an overview of devices on which some implementations of the disclosed technology can operate. The devices can comprise hardware components of a computing system **100** that assigns display mode timers, that are based on context factors such as user focus, to virtual objects to control when the virtual objects transition between display modes. In various implementations, computing system **100** can include a single computing device **103** or multiple computing devices (e.g., computing device **101**, computing device **102**, and computing device **103**) that communicate over wired or wireless channels to distribute processing and share input data. In some implementations, computing system **100** can include a stand-alone headset capable of providing a computer created or augmented experience for a user without the need for external processing or sensors. In other implementations, computing system **100** can include multiple computing devices such as a headset and a core processing component (such as a console, mobile device, or server system) where some processing operations are performed on the headset and others are offloaded to the core processing component. Example headsets are described below in relation to FIGS. **2**A and **2**B. In some implementations, position and environment data can be gathered only by sensors incorporated in the headset device, while in other implementations one or more of the non-headset computing devices can include sensor components that can track environment or position data.

Computing system **100** can include one or more processor(s) **110** (e.g., central processing units (CPUs), graphical processing units (GPUs), holographic processing units (HPUs), etc.) Processors **110** can be a single processing unit or multiple processing units in a device or distributed across multiple devices (e.g., distributed across two or more of computing devices **101**-**103**).

Computing system **100** can include one or more input devices **120** that provide input to the processors **110**, notifying them of actions. The actions can be mediated by a hardware controller that interprets the signals received from the input device and communicates the information to the processors **110** using a communication protocol. Each input device **120** can include, for example, a mouse, a keyboard, a touchscreen, a touchpad, a wearable input device (e.g., a haptics glove, a bracelet, a ring, an earring, a necklace, a watch, etc.), a camera (or other light-based input device, e.g., an infrared sensor), a microphone, or other user input devices.

Processors **110** can be coupled to other hardware devices, for example, with the use of an internal or external bus, such as a PCI bus, SCSI bus, or wireless connection. The processors **110** can communicate with a hardware controller for devices, such as for a display **130**. Display **130** can be used to display text and graphics. In some implementations, display **130** includes the input device as part of the display, such as when the input device is a touchscreen or is equipped with an eye direction monitoring system. In some implementations, the display is separate from the input device. Examples of display devices are: an LCD display screen, an LED display screen, a projected, holographic, or augmented reality display (such as a heads-up display device or a head-mounted device), and so on. Other I/O devices **140** can also be coupled to the processor, such as a network chip or card, video chip or card, audio chip or card, USB, firewire or other external device, camera, printer, speakers, CD-ROM drive, DVD drive, disk drive, etc.

Computing system **100** can include a communication device capable of communicating wirelessly or wire-based with other local computing devices or a network node. The communication device can communicate with another device or a server through a network using, for example, TCP/IP protocols. Computing system **100** can utilize the communication device to distribute operations across multiple network devices.

The processors **110** can have access to a memory **150**, which can be contained on one of the computing devices of computing system **100** or can be distributed across of the multiple computing devices of computing system **100** or other external devices. A memory includes one or more hardware devices for volatile or non-volatile storage, and can include both read-only and writable memory. For example, a memory can include one or more of random access memory (RAM), various caches, CPU registers, read-only memory (ROM), and writable non-volatile memory, such as flash memory, hard drives, floppy disks, CDs, DVDs, magnetic storage devices, tape drives, and so forth. A memory is not a propagating signal divorced from underlying hardware; a memory is thus non-transitory. Memory **150** can include program memory **160** that stores programs and software, such as an operating system **162**, virtual object metering system **164**, and other application programs **166**. Memory **150** can also include data memory **170** that can, for example, include display mode timer properties, configurations, or data structures; context factor values; data structures for virtual objects (or clusters of virtual objects); artificial reality system modes or settings; a registry of which virtual objects to provide with which context factors; user options; settings; preferences; etc., which can be provided to the program memory **160** or any element of the computing system **100**.

Some implementations can be operational with numerous other computing system environments or configurations. Examples of computing systems, environments, and/or configurations that may be suitable for use with the technology include, but are not limited to, XR headsets, personal computers, server computers, handheld or laptop devices, cellular telephones, wearable electronics, gaming consoles, tablet devices, multiprocessor systems, microprocessor-based systems, set-top boxes, programmable consumer electronics, network PCs, minicomputers, mainframe computers, distributed computing environments that include any of the above systems or devices, or the like.

FIG. **2**A is a wire diagram of a virtual reality head-mounted display (HMD) **200**, in accordance with some embodiments. The HMD **200** includes a front rigid body **205** and a band **210**. The front rigid body **205** includes one or more electronic display elements of an electronic display **245**, an inertial motion unit (IMU) **215**, one or more position sensors **220**, locators **225**, and one or more compute units **230**. The position sensors **220**, the IMU **215**, and compute units **230** may be internal to the HMD **200** and may not be visible to the user. In various implementations, the IMU **215**, position sensors **220**, and locators **225** can track movement and location of the HMD **200** in the real world and in a virtual environment in three degrees of freedom (3DoF) or six degrees of freedom (6DoF). For example, the locators **225** can emit infrared light beams which create light points on real objects around the HMD **200**. As another example, the IMU **215** can include e.g., one or more accelerometers, gyroscopes, magnetometers, other non-camera-based position, force, or orientation sensors, or combinations thereof. One or more cameras (not shown) integrated with the HMD **200** can detect the light points. Compute units **230** in the

HMD **200** can use the detected light points to extrapolate position and movement of the HMD **200** as well as to identify the shape and position of the real objects surrounding the HMD **200**.

The electronic display **245** can be integrated with the front rigid body **205** and can provide image light to a user as dictated by the compute units **230**. In various embodiments, the electronic display **245** can be a single electronic display or multiple electronic displays (e.g., a display for each user eye). Examples of the electronic display **245** include: a liquid crystal display (LCD), an organic light-emitting diode (OLED) display, an active-matrix organic light-emitting diode display (AMOLED), a display including one or more quantum dot light-emitting diode (QOLED) sub-pixels, a projector unit (e.g., microLED, LASER, etc.), some other display, or some combination thereof.

In some implementations, the HMD **200** can be coupled to a core processing component such as a personal computer (PC) (not shown) and/or one or more external sensors (not shown). The external sensors can monitor the HMD **200** (e.g., via light emitted from the HMD **200**) which the PC can use, in combination with output from the IMU **215** and position sensors **220**, to determine the location and movement of the HMD **200**.

In some implementations, the HMD **200** can be in communication with one or more other external devices, such as controllers (not shown) which a user can hold in one or both hands. The controllers can have their own IMU units, position sensors, and/or can emit further light points. The HMD **200** or external sensors can track these controller light points. The compute units **230** in the HMD **200** or the core processing component can use this tracking, in combination with IMU and position output, to monitor hand positions and motions of the user. The controllers can also include various buttons a user can actuate to provide input and interact with virtual objects. In various implementations, the HMD **200** can also include additional subsystems, such as an eye tracking unit, an audio system, various network components, etc. In some implementations, instead of or in addition to controllers, one or more cameras included in the HMD **200** or external to it can monitor the positions and poses of the user's hands to determine gestures and other hand and body motions.

FIG. **2**B is a wire diagram of a mixed reality HMD system **250** which includes a mixed reality HMD **252** and a core processing component **254**. The mixed reality HMD **252** and the core processing component **254** can communicate via a wireless connection (e.g., a 60 GHz link) as indicated by link **256**. In other implementations, the mixed reality system **250** includes a headset only, without an external compute device or includes other wired or wireless connections between the mixed reality HMD **252** and the core processing component **254**. The mixed reality HMD **252** includes a pass-through display **258** and a frame **260**. The frame **260** can house various electronic components (not shown) such as light projectors (e.g., LASERs, LEDs, etc.), cameras, eye-tracking sensors, MEMS components, networking components, etc.

The projectors can be coupled to the pass-through display **258**, e.g., via optical elements, to display media to a user. The optical elements can include one or more waveguide assemblies, reflectors, lenses, mirrors, collimators, gratings, etc., for directing light from the projectors to a user's eye. Image data can be transmitted from the core processing component **254** via link **256** to HMD **252**. Controllers in the HMD **252** can convert the image data into light pulses from the projectors, which can be transmitted via the optical elements as output light to the user's eye. The output light can mix with light that passes through the display **258**, allowing the output light to present virtual objects that appear as if they exist in the real world.

Similarly to the HMD **200**, the HMD system **250** can also include motion and position tracking units, cameras, light sources, etc., which allow the HMD system **250** to, e.g., track itself in 3DoF or 6DoF, track portions of the user (e.g., hands, feet, head, or other body parts), map virtual objects to appear as stationary as the HMD **252** moves, and have virtual objects react to gestures and other real-world objects.

FIG. **3** is a block diagram illustrating an overview of an environment **300** in which some implementations of the disclosed technology can operate. Environment **300** can include one or more client computing devices **305**A-D, examples of which can include computing system **100**. In some implementations, some of the client computing devices (e.g., client computing device **305**B) can be the HMD **200** or the HMD system **250**. Client computing devices **305** can operate in a networked environment using logical connections through network **330** to one or more remote computers, such as a server computing device.

In some implementations, server **310** can be an edge server which receives client requests and coordinates fulfillment of those requests through other servers, such as servers **320**A-C. Server computing devices **310** and **320** can comprise computing systems, such as computing system **100**. Though each server computing device **310** and **320** is displayed logically as a single server, server computing devices can each be a distributed computing environment encompassing multiple computing devices located at the same or at geographically disparate physical locations.

Client computing devices **305** and server computing devices **310** and **320** can each act as a server or client to other server/client device(s). Server **310** can connect to a database **315**. Servers **320**A-C can each connect to a corresponding database **325**A-C. As discussed above, each server **310** or **320** can correspond to a group of servers, and each of these servers can share a database or can have their own database. Though databases **315** and **325** are displayed logically as single units, databases **315** and **325** can each be a distributed computing environment encompassing multiple computing devices, can be located within their corresponding server, or can be located at the same or at geographically disparate physical locations.

Network **330** can be a local area network (LAN), a wide area network (WAN), a mesh network, a hybrid network, or other wired or wireless networks. Network **330** may be the Internet or some other public or private network. Client computing devices **305** can be connected to network **330** through a network interface, such as by wired or wireless communication. While the connections between server **310** and servers **320** are shown as separate connections, these connections can be any kind of local, wide area, wired, or wireless network, including network **330** or a separate public or private network.

FIG. **4** is a block diagram illustrating components **400** which, in some implementations, can be used in a system employing the disclosed technology. Components **400** can be included in one device of computing system **100** or can be distributed across multiple of the devices of computing system **100**. The components **400** include hardware **410**, mediator **420**, and specialized components **430**. As discussed above, a system implementing the disclosed technology can use various hardware including processing units **412**, working memory **414**, input and output devices **416** (e.g., cameras, displays, IMU units, network connections, etc.), and storage memory **418**. In various implementations, storage memory **418** can be one or more of: local devices, interfaces to remote storage devices, or combinations thereof. For example, storage memory **418** can be one or more hard drives or flash drives accessible through a system bus or can be a cloud storage provider (such as in storage **315** or **325**) or other network storage accessible via one or more communications networks. In various implementations, components **400** can be implemented in a client computing device such as client computing devices **305** or on a server computing device, such as server computing device **310** or **320**.

Mediator **420** can include components which mediate resources between hardware **410** and specialized components **430**. For example, mediator **420** can include an operating system, services, drivers, a basic input output system (BIOS), controller circuits, or other hardware or software systems.

Specialized components **430** can include software or hardware configured to perform operations for assigning and administering display mode timers for virtual objects. Specialized components **430** can include virtual object controller **434**, display mode timer manager **436**, context factor tractor **438**, and components and APIs which can be used for providing user interfaces, transferring data, and controlling the specialized components, such as interfaces **432**. In some implementations, components **400** can be in a computing system that is distributed across multiple computing devices or can be an interface to a server-based application executing one or more of specialized components **430**. Although depicted as separate components, specialized components **430** may be logical or other nonphysical differentiations of functions and/or may be submodules or code-blocks of one or more applications.

Virtual object controller **434** can receive requests for new virtual objects. In some cases, a request can be associated with mappings of display modes to display mode timer ranges and/or other rules for setting display mode timer properties. The virtual object controller **434** can create the requested object and respond to the request with access to the new virtual object. In some implementations, the virtual object can be associated with a display mode timer created by display mode timer manager **436**. Virtual object controller **434** can also enforce constraints for the virtual objects, ensuring they conform to the constraints (e.g., size, shape, etc.) when certain display modes are enabled. Additional details on creating and controlling virtual objects are discussed below in relation to blocks **502** and **514** of FIG. **5** and block **608** of FIG. **6**.

Display mode timer manager **436** can set up display mode timers for virtual objects created by virtual object controller **434**. Display mode timer manager **436** can also receive values for context factors (from context factor tracker **438**) and apply them to rules for the display mode timer. In some implementations, this can be performed by a version of display mode timer manager **436** controlled by the virtual object. In response to evaluating the rules based on the context factor values, the display mode timer manager **436** can add or remove time from the display mode timer or change display mode timer properties (e.g., countdown speed, range to display mode mappings, maximum time, etc.) As time elapses, the display mode timer manager **436** can also decrement the time on a display mode timer. Additional details on creating and controlling display mode timers are discussed below in relation to blocks **510-512** of FIG. **5** and **602-606** of FIG. **6**.

Context factor tractor **438** can maintain a registry of which display mode timers should receive which context factors. In some cases, context factor tractor **438** can accomplish this by analyzing the rules set for each display mode timer to determine which context factors are used by the rules for that display mode timer. In other cases, all display mode timers have the same rules, allowing for a pre-specified set of context factors that are provided to all display mode timers. Context factor tractor **438** can also monitor for context factors values being set or changed by a threshold amount and, when this occurs, can use the registry to provide the values for those context factors to the display mode timers registered to receive them. Additional details on registering display mode timers for context factors and providing context factor values to the display mode timers are discussed below in relation to blocks **504** and **506** of FIG. **5**.

Those skilled in the art will appreciate that the components illustrated in FIGS. **1-4** described above, and in each of the flow diagrams discussed below, may be altered in a variety of ways. For example, the order of the logic may be rearranged, substeps may be performed in parallel, illustrated logic may be omitted, other logic may be included, etc. In some implementations, one or more of the components described above can execute one or more of the processes described below.

FIG. **5** is a flow diagram illustrating a process **500** used in some implementations of the present technology for creating a virtual object with a display mode timer and adjusting the display mode timer in response to context factors. In some implementations, process **500** can begin when a new virtual object is created. In some cases, all virtual objects receive display mode timers causing an execution of process **500** for each. In other cases, only virtual objects of certain types, created by certain applications, or when requested with certain parameters (e.g., a display mode timer parameter) are assigned a display mode timer, causing a corresponding execution of process **500**. In some implementations, process **500** can be executed by part of a controller (i.e., a "shell") for the artificial reality environment that can control how artificial reality environment information and objects appear to users, what interactions can be performed, and what interactions are provided to applications. In some implementations, portions of process **500** can be performed by the shell while other portions are controlled by the virtual object or an application in control of the virtual object. For example, in some implementations, each display mode timer is controlled by a corresponding virtual object or the application that controls that corresponding virtual object, so blocks **502-506** can be performed by the shell while blocks **508-514** are performed by the virtual object or virtual object controlling application. In other implementations, the display mode timers are controlled by the shell, so blocks **502-512** can be performed by the shell while block **514** is performed by the virtual object or virtual object controlling application. Other implementations can divide process **500** differently or parts can be performed by other entities.

At block **502**, process **500** can create a virtual object with an associated display mode timer. In some cases, the virtual object can be created in response to a new object request. Such virtual objects can be wholly virtual objects or additions for real-world objects, such as an effect applied to a person or thing. The display mode timer associated with a created virtual object can have properties such as a countdown speed, a mapping of time ranges to display modes, an initial amount of time on the display mode timer, a maximum amount of time the display mode timer can have, or rules specifying what context factors cause these properties to change and how. In various cases, the request for a new object can specify one or more of the display mode timer properties, the created virtual object can have a specified type that is associated with default display mode timer properties for that type, and/or all virtual objects can have some default display mode timer properties.

In various implementations, the display modes mapped to time ranges of a display mode timer can be custom for a particular virtual object or can be set the same for all virtual objects. In some cases, a combination of custom and default display mode mappings can be used, e.g., where the system specifies certain display modes that each virtual object must have, but the virtual object request can define the ranges for those display modes and/or can define additional display modes with further ranges. In various implementations, the display modes can include one or more of a maximized display mode, a minimized display mode, a glint display mode, a key-action display mode, a notifications-only display mode, and/or an audio-only display mode.

Each display mode can specify parameters for displaying objects in that mode, such as a maximum size for virtual objects, a percentage of the FOV a virtual object can take up, a percentage of the virtual object's full size that can be used while in that mode, a particular shape the virtual object can take in that mode, corresponding features the virtual object should display in that mode, how much processing power the virtual object can use (e.g., how often the virtual object can "wake up" and/or how much to throttle the processing threads allocated to a virtual object), and/or what the virtual object can display while in that mode. In some cases, when a virtual object is created, a request sent to the artificial reality system shell specifies characteristics of the virtual object display modes for the shell to approve when creating the volume. For example, a virtual object may be created by a request to the artificial reality system shell that allocates a volume for the virtual object.

The maximized display mode may allow a virtual object to be any size or to use the full amount of space allocated to it at creation. The minimized display mode can set a maximum size for a virtual object, reduce the size of the allocated virtual object volume by a percentage (e.g., 25%, 50%, or 75%), restrict the virtual object to a certain amount of the user's FOV (e.g., no more than 3%, 5%, or 10%), dim the virtual object or make it semi-transparent, or combinations thereof. The glint display mode can restrict the virtual object to a particular shape such as a "coin" shape with an icon, a 2D panel, or just a floating icon. A key-action display mode can show just certain controls for the virtual object. By way of example, a virtual object for a media player can just show the most often used media player controls, while a virtual object representing a person can just show controls for messaging that person and for tagging that person in a social media post. In some cases, the key-action display mode can be paired with another display mode, such as the glint display mode, such that the glint and the key actions are displayed together. In some implementations, the key-actions display mode can be triggered by a context factor other than the display mode timer, such as when the user's focus is directed to a virtual object in glint mode (see the example described below with reference to FIG. 7E). The notifications-only display mode can hide a virtual object until it has a notification event to display to the user. For example, a virtual object that presents a user interface (UI) for a messaging app can hide itself until a message comes in, at which point it can enter glint mode with an indication that there is a notification or a preview of the notification. In some cases, virtual objects in glint mode or in notification-only mode can be moved to a different location in the artificial reality environment, such as a docking surface to the side of the user's FOV or to a virtual object panel that the user can call up to reactivate virtual objects. In some implementations, display modes can individually control different types of virtual object output, such as visual output, audio output, haptic output, etc. For example, a display mode can be "audio-only" causing a virtual object to turn off all visual display while allowing audio output. As another example, a "conversation" display mode can mute all virtual object audio while a user is identified as having a conversation.

In some cases, the artificial reality system can impose constraints defining how a virtual object can write to the display when in particular display modes (e.g., how much of the display it can use, where it can be placed, how often it can wake up, etc.) In some cases, these constraints can be applied by verifying, at virtual object creation (e.g., by the shell), that the display modes defined for virtual objects conform to these maximums. This constraint system can be used where the virtual object and/or other virtual objects and applications that control the virtual object do not have access to later change these display mode parameters. In other cases, the shell can actively impose these constraints, e.g., by restricting the size or shape that a virtual object can use when the shell indicates the virtual object should enter a particular display mode.

In some implementations, virtual objects can be clustered (e.g., based on a type assigned to the virtual objects, a type of data the virtual objects work on, user selections of virtual object groupings, the virtual objects having a common creating entity, etc.). A cluster of virtual objects can share a display mode timer or can have their display mode timers synchronized. For example, when time is added to a display mode timer for one virtual object in a cluster in response to the user's focus being directed to that virtual object, time can be added to the other display mode timers for virtual objects in that cluster. In various implementations, the same amount of time can be added to each such display mode timer or different amounts can be added, e.g., by adding more time to the display mode timer for the virtual object that was the subject of the user focus.

While as discussed above, in various implementations, blocks of the processes described here can be removed or rearranged, block **504** is shown in broken lines to call out that block **504** may not be performed in some instances. For example, in some implementations, display mode timers can have a consistent set of rules for how context factors cause time to be added or removed and/or for changing display mode timer properties. In these cases, the relevant context factors to provide for adjusting a display mode timer are pre-determined so there is no need to identify such context factors at block **504**. In other implementations, different display mode timers can have different such rules, and block **504** can be performed to identify which context factors should be provided to the display mode timer associated with the virtual object created at block **502**. Process **500** can accomplish this by reviewing the rules established for the display mode timer when the associated virtual object was created at block **502** (e.g., specified in a shell request for the new virtual object) and identifying which context factors those rules rely upon. The identified context factors can be stored in a registry that maps context factors to virtual objects. In some implementations, the registry can specify a level of change in context factor values that must occur for that context factor to be provided to the display mode timer.

In other cases, such thresholds can be previously established for various context factors. For example, a context factor for ambient lighting can specify a threshold change in number of lumens that will cause the value for this context factor to be reported to display mode timers registered to receive it. In some implementations, the only context factor used to add time to a display mode timer is user focus.

At block **506**, process **500** can identify context factor(s) that have been set or changed which should be reported to the virtual object created at block **502**. In some implementations, identifying the context factors can be based on which context factors the display mode timer is registered, at block **504**, to receive. In other implementations, identifying the context factors can be based on which context factors are pre-established to be provided to display mode timers or display mode timers of particular types. Identifying a context factor to provide to a display mode timer can include determining that a new value for a context factor has been set or that a new value for a context factor is a threshold amount different from a previous value set for that context factor. As discussed above, the registry can specify these thresholds for particular display mode timers, or such thresholds can be previously established for various context factors. In some implementations, instead of the shell pushing context factor values to display mode timers, the display mode timer can periodically pull the values for context factors it needs to update itself.

Examples of context factors that can be used to adjust display mode timer properties include indicators of user focus (e.g., user gaze direction, user proximity to the associated virtual object, an indication that the virtual object is in the user's FOV or is within a threshold distance from a center of the FOV, that a user has provided input to the virtual object e.g., through a gesture, a voice command, a controller selection, etc.); that an application associated with the virtual object is in a mode to keep itself awake (e.g., when playing music); when the virtual object receives an action (e.g., receives data or a notification from an external source); a current mode or state of the artificial reality system state (e.g., low power, active mode, movement below a threshold, etc.); or specifics of the virtual object such as power drain by that virtual object or whether the virtual object is providing active output (e.g., audio, video, displaying "live data" that is periodically retrieved from or kept synchronized with an external source). In some implementations, the rate at which the display mode timer counts down (i.e., a "countdown speed") is a property that can be adjusted. In various implementations, some of the context factors that can affect this property can include the following: whether the associated virtual object is positioned relative to the user (e.g., pinned to the user, on a surface that moves with the user, etc.) which can cause the countdown speed to decrease, whether the artificial reality system is in low power mode or whether the associated virtual object is determined to be drawing above a threshold amount of power which can cause the countdown speed to increase, whether a virtual object is under the control of certain applications or identified types of applications which can cause the countdown speed to decrease or increase depending on associated rules, or the countdown speed can be set proportional to the distance of the virtual object to the user in the artificial reality environment (e.g., the closer the virtual object is to the user, the slower the countdown speed).

At block **508**, process **500** can determine whether the virtual object is eligible for a display mode timer update. For example, a display mode timer may be disabled when the associated virtual object is providing active output or otherwise in a keep-active mode. In some cases, a display mode timer may not be eligible to be updated when it has entered a particular display mode. For example, a display mode timer may not be eligible to have time added to it once it has entered glint mode until a particular user action has occurred (e.g., an explicit maximization of the virtual object). If the display mode timer for the virtual object is eligible for an update, process **500** can continue to block **510**. Otherwise, process **500** can return to block **506**.

At block **510**, process **500** can adjust the display mode timer, for the virtual object created at block **502**, based on the values for the context factors identified at block **506**. Updating the display mode timer properties can be controlled by the rules specified for the display mode timer (e.g., specifically for the display mode timer, for display mode timers of a particular type, or for display mode timers generally). For example, a context factor with an indication that a user's focus was on the virtual object can add time to the display mode timer; the artificial reality system entering power saving mode can remove time from the display mode timer or can increase the display mode timer's countdown speed; the virtual object receiving a notification can add time to the display mode timer; the virtual object providing active output can add time to the display mode timer; the virtual object coming under the control of a high priority application can cause the maximum time for the display mode timer to be increased or can specify a new mapping of ranges of the display mode timer to display modes; etc. Many other rules can be specified that map context factor changes to changes in display mode timer properties.

At block **512**, process **500** can determine whether the current state of the display mode timer, with the adjustments made at block **510**, indicates the current amount of time on the display mode timer is mapped to a display mode other than a current display mode of the virtual object. If so, process **500** can proceed to block **514**. Otherwise, process **500** can return to block **506**.

At block **514**, process **500** can cause the new display mode that corresponds to the current state of the display mode timer to be enabled. This can include indicating to the virtual object which display mode to enable. In some implementations, this can also include the artificial reality system shell enabling constraints corresponding to the new display mode, ensuring that the virtual object does not present itself in a manner inconsistent with those constraints. For example, the shell can specify a maximum size or a shape for the virtual object in the current display mode. Process **500** can then return to block **506** to await a further change in context factors to report to the virtual object.

FIG. **6** is a flow diagram illustrating a process **600** used in some implementations of the present technology for decrementing a display mode timer of a virtual object and setting a display mode for the virtual object according to the display mode timer. Process **600** can begin execution in response to creation of an object with an associated display mode timer (e.g., block **502** of FIG. **5**). In some implementations, process **600** can be paused or disabled when the display mode timer is paused or disabled, e.g., if a virtual object is in a mode to keep it in a current display mode (such as when the virtual object is providing active output or otherwise in a keep-active mode).

At block **602**, process **600** can identify a trigger for updating the display mode timer. In some implementations, this trigger can be periodic, e.g., a trigger that occurs every 0.1, 0.5, or 1 second. At block **604**, process **600** can decrement the display mode timer. In some implementations, the amount decremented can correspond to the period between the triggers used at block **602**. In some implementations where the display mode timer has an associated countdown speed property (discussed above), the amount the display mode timer is decremented can be weighted based on the value of the countdown speed property.

At block **606**, process **600** can determine whether the current state of the display mode timer, with the decrement made at block **604**, indicates the current amount of time on the display mode timer is mapped to a display mode other than a current display mode of the virtual object. If so, process **600** can proceed to block **608**. Otherwise, process **600** can return to block **602**.

At block **608**, process **600** can cause the new display mode that corresponds to the current state of the display mode timer to be enabled. This can include indicating to the virtual object which display mode to enable. In some implementations, this can also include the artificial reality system shell enabling constraints corresponding to the new display mode, ensuring that the virtual object does not present itself in a manner inconsistent with those constraints. For example, the shell can specify a maximum size or a shape for the virtual object in the current display mode. Process **600** can then return to block **602** to await the next display mode timer update trigger.

FIG. **7**A is a conceptual diagram illustrating an example **700** with a virtual object **704**, in a maximized display mode, with a display mode timer **706** controlled by user gaze and power level context factors. Example **700** show artificial reality environment **702** which includes a music player virtual object **704**, a picture virtual object **718**, an apple virtual object **722**, and a soccer ball virtual object **728**. Each of these virtual objects is associated with a display mode timer: music player **704** is associated with display mode timer **706**, picture **718** is associated with display mode timer **720**, apple **722** is associated with display mode timer **724**, and soccer ball **726** is associated with display mode timer **728**. In example **700**, the display mode timers **706**, **720**, **722**, and **728** are illustrated as being displayed in the artificial reality environment. However, in some cases the display mode timers are not visually perceptible in the artificial reality environment. As illustrated by the segmentation of the display mode timers **706**, **720**, **722**, and **728** (such as segments **708**, **710**, and **712** of display mode timer **706**), the display mode timers **706**, **720**, **722**, and **728** are divided into ranges corresponding to different display modes. In example **700**, the display mode timers **706**, **720**, **722**, and **728** each have a different range segmentation. For example, display mode timer **706** has range **708** corresponding to glint display mode, range **710** corresponding to minimized display mode, and range **712** corresponding to maximized display mode, while display mode timer **728** has range **732** corresponding to glint display mode and range **730** corresponding to maximized display mode. In FIG. **7**A, display mode timer **706** has time in range **712**, causing virtual object **704** to be in maximized display mode—displayed at full size with all its associated controls. Display mode timer **728** has time in range **732**, causing virtual object **726** to be in glint display mode—displaying only a “coin” shape with an icon for the content of the virtual object **726**.

Example **700** also includes a countdown speed **714**, as a property of the display mode timer **706**. Countdown speed **714** is illustrated as an arrow with a magnitude of the arrow tail signifying the speed at which time is decremented from the display mode timer **706**. In example **700**, the countdown speed **714** is illustrated as being displayed in the artificial reality environment. However, in some cases the countdown speed **714** is not visually perceptible in the artificial reality environment but is tracked as a property of the display mode timer **706**. The artificial reality system controlling artificial reality environment **702** is also tracking a variety of context factors, including user focus **716**.

FIG. **7**B is a conceptual diagram illustrating the example **700** with virtual object **704** where the display mode timer **706** has decreased to time in range **710**. This caused the display mode of the music player virtual object **704** to change to a minimized display mode. The minimized display mode includes a constraint to decrease the virtual object **704**’s size by half. The virtual object **704** is configured to change the size of and rearrange the content items it displays to conform to the decreased size in this minimized display mode. As also seen in FIG. **7**B, user focus **716** has been directed to the soccer ball virtual object **726**, causing time to be added to display mode timer **728**. The time added to display mode timer **728** has moved it into the **730** range, causing the soccer ball **726** to be displayed in maximized mode.

FIG. **7**C is a conceptual diagram illustrating the example **700** with virtual object **704** where the display mode timer **706** has increased based on a user gaze **716** being directed at the virtual object **704**. The time added to display mode timer **706** has moved it back into the **712** range, causing the media player virtual object **704** to be again displayed in maximized mode.

FIG. **7**D is a conceptual diagram illustrating the example **700** with virtual object **704** where the countdown speed **714** (the rate at which the display mode timer **706** decrements) has increased. In example **700**, this has occurred in response to a context factor specifying that a mode of the artificial reality system is “power saving.” As the display mode timer **706** has counted down at this increased rate, display mode timer **706** entered range **708**. Range **708** is mapped to glint mode, so the media player virtual object **704** is displayed in glint mode—shown as an icon of a specified size.

FIG. **7**E is a conceptual diagram illustrating the example **700** virtual object **704** remaining in the glint mode, adding key actions **734**. In example **700**, once virtual object **704** has entered glint display mode, it is configured to remain in glint display mode until the user is focused on the virtual object **704** and performs a maximization gesture. Thus, user focus **716** being directed at virtual object **704** alone does not add time to display mode timer **706**. However, virtual object **704** is configured to also enter key-actions display mode when it is in glint display mode and the user’s focus **716** is directed at it. As shown in FIG. **7**E, key-actions display mode causes key actions **734** to be displayed relative to virtual object **704**. Key actions **734** include the controls determined most likely to be used for the corresponding virtual object **704**. In this case, virtual object **704** is a music player and the key actions include a stop control, a play control, and a volume control. In FIG. **7**F, the user has kept her focus **716** on the virtual object **704** and has performed the maximization gesture (not shown). This causes display mode timer **706** to be set to its maximum level. The time added to display mode timer **706** has moved it back into the **712** range, causing the media player virtual object **704** to be once again displayed in maximized mode.

Reference in this specification to “implementations” (e.g., “some implementations,” “various implementations,” “one implementation,” “an implementation,” etc.) means that a particular feature, structure, or characteristic described in connection with the implementation is included in at least one implementation of the disclosure. The appearances of these phrases in various places in the specification are not necessarily all referring to the same implementation, nor are separate or alternative implementations mutually exclusive of other implementations. Moreover, various features are described which may be exhibited by some implementations and not by others. Similarly, various requirements are described which may be requirements for some implementations but not for other implementations.

As used herein, being above a threshold means that a value for an item under comparison is above a specified other value, that an item under comparison is among a certain specified number of items with the largest value, or that an item under comparison has a value within a specified top percentage value. As used herein, being below a threshold means that a value for an item under comparison is below a specified other value, that an item under comparison is among a certain specified number of items with the smallest value, or that an item under comparison has a value within a specified bottom percentage value. As used herein, being within a threshold means that a value for an item under comparison is between two specified other values, that an item under comparison is among a middle-specified number of items, or that an item under comparison has a value within a middle-specified percentage range. Relative terms, such as high or unimportant, when not otherwise defined, can be understood as assigning a value and determining how that value compares to an established threshold. For example, the phrase "selecting a fast connection" can be understood to mean selecting a connection that has a value assigned corresponding to its connection speed that is above a threshold.

As used herein, the word "or" refers to any possible permutation of a set of items. For example, the phrase "A, B, or C" refers to at least one of A, B, C, or any combination thereof, such as any of: A; B; C; A and B; A and C; B and C; A, B, and C; or multiple of any item such as A and A; B, B, and C; A, A, B, C, and C; etc.

Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Specific embodiments and implementations have been described herein for purposes of illustration, but various modifications can be made without deviating from the scope of the embodiments and implementations. The specific features and acts described above are disclosed as example forms of implementing the claims that follow. Accordingly, the embodiments and implementations are not limited except as by the appended claims.

Any patents, patent applications, and other references noted above are incorporated herein by reference. Aspects can be modified, if necessary, to employ the systems, functions, and concepts of the various references described above to provide yet further implementations. If statements or subject matter in a document incorporated by reference conflicts with statements or subject matter of this application, then this application shall control.

We claim:

1. A method for displaying a virtual object in an artificial reality environment, the method comprising:

causing a display mode timer to be associated with the virtual object, wherein multiple ranges of the display mode timer are each mapped to one of multiple display modes and the display mode timer elapses at a specified rate;

identifying one or more context factors specifying conditions related to the artificial reality environment, wherein at least one of the one or more context factors indicates a user focus in the artificial reality environment;

evaluating, based on the one or more context factors, one or more rules for the virtual object;

in response to the evaluating, including determining that the user focus is on the virtual object, adding time to the display mode timer;

determining that the time added to the display mode timer caused the display mode timer to have an amount of time in one of the multiple ranges mapped to a new display mode other than a current display mode of the virtual object; and

causing the virtual object to change to the new display mode.

2. The method of claim **1**,

wherein the specified rate for the display mode timer is variable depending on at least one of the one or more context factors; and

wherein the method further comprises increasing the specified rate in response to a determination, based on the one or more context factors, including one or more of:

that an amount of space the virtual object takes on a display is above a threshold space;

that a power saving mode has been enabled;

that the virtual object is above a threshold distance, in the artificial reality environment, from a user; or

any combination thereof.

3. The method of claim **1**, wherein the specified rate for the display mode timer is variable depending on at least one of the one or more context factors.

4. The method of claim **1**, wherein the new display mode is a maximized display mode in which the virtual object can use a full amount of a volume allocated for that virtual object.

5. The method of claim **1**, wherein the new display mode is a minimized display mode in which a constraint is set such that the virtual object can use less than a full amount of a volume allocated for that virtual object.

6. The method of claim **1**,

wherein the new display mode is a glint display mode in which a constraint is set such that the virtual object is displayed in a shape specified for all virtual objects that are in the glint display mode; and

wherein, when the virtual object is in the glint display mode, causing the virtual object to enable a display mode other than the glint display mode requires a user interaction specified for exiting glint mode.

7. The method of claim **1**, wherein the new display mode is a glint display mode in which a constraint is set such that the virtual object is displayed in a shape specified for all virtual objects that are in the glint display mode.

8. The method of claim **1**,

wherein one of the multiple display modes includes a key-actions configuration in which certain controls are displayed in relation to the virtual object; and

wherein the certain controls are controls identified as most often used in relation to the virtual object.

9. The method of claim **1**,

wherein the new display mode is associated with one or more constraints including:

how much of a display the virtual object can use, or

where in the artificial reality environment the virtual object can be placed; and wherein, when the virtual object changes to the new display mode, the one or more constraints associated with the new display mode are enforced.

10. The method of claim 1,

wherein the virtual object is part of a cluster of multiple virtual objects;

wherein the cluster of multiple virtual objects was defined based on one or more of:

having been created by the same entity,

having a common specified type,

having been grouped by a user, or

any combination thereof; and

wherein the display mode timer associated with the virtual object is:

assigned to the cluster of multiple virtual objects; or

is synchronized with one or more other display mode timers associated with one or more of the multiple virtual objects.

11. The method of claim 1,

wherein the virtual object is part of a cluster of multiple virtual objects; and

wherein the display mode timer associated with the virtual object is:

assigned to the cluster of multiple virtual objects; or

is synchronized with one or more other display mode timers associated with one or more of the multiple virtual objects.

12. The method of claim 1, wherein the evaluating the one or more rules for the virtual object includes determining that the user focus is directed at the virtual object.

13. A computer-readable storage medium storing instructions that, when executed by a computing system, cause the computing system to perform a process for displaying a virtual object in an artificial reality environment, the process comprising:

receiving one or more context factors specifying conditions related to the artificial reality environment;

evaluating, based on the one or more context factors, one or more rules for the virtual object;

in response to the evaluating, adding time to a display mode timer associated with the virtual object, wherein multiple ranges of the display mode timer are each mapped to one of multiple display modes;

determining that the time added to the display mode timer caused the display mode timer to have an amount of time in one of the multiple ranges mapped to a new display mode other than a current display mode of the virtual object; and

causing the virtual object to change to the new display mode.

14. The computer-readable storage medium of claim 13, wherein the one or more context factors include:

user proximity, in the artificial reality environment, to the virtual object;

that a user input has been provided in relation to the virtual object;

a current mode of an artificial reality system in control of the artificial reality environment;

an amount of power used to display the virtual object; or

any combination thereof.

15. The computer-readable storage medium of claim 13, wherein the process further comprises determining that the virtual object is providing active output and, in response, preventing a further change in display mode while the virtual object is providing the active output.

16. The computer-readable storage medium of claim 13,

wherein the display mode timer elapses at a specified rate; and

wherein the process further comprises increasing the specified rate in response to a determination, based on the one or more context factors, including one or more of:

that a power saving mode has been enabled;

that the virtual object is above a threshold distance, in the artificial reality environment, from the user; or

any combination thereof.

17. The computer-readable storage medium of claim 13,

wherein the one or more context factors specify at least a user gaze direction; and

wherein the evaluating the one or more rules for the virtual object includes determining that the user gaze direction is directed at the virtual object.

18. A computing system for displaying a virtual object in an artificial reality environment, the computing system comprising:

one or more processors; and

one or more memories storing instructions that, when executed by the one or more processors, cause the computing system to perform a process comprising:

causing a display mode timer to be associated with the virtual object, wherein multiple ranges of the display mode timer are each mapped to one of multiple display modes and the display mode timer elapses at a specified rate, and wherein the multiple ranges of the display mode timer include at least three ranges;

in response to the display mode timer elapsing, determining that the display mode timer has an amount of time in one of the multiple ranges that is mapped to a new display mode other than a current display mode of the virtual object; and

causing the virtual object to change to the new display mode.

19. The computing system of claim 18,

wherein the process further comprises:

receiving one or more context factors specifying conditions related to the artificial reality environment; and

based on the one or more context factors, adding time to the display mode timer associated with the virtual object; and

wherein the one or more context factors include:

that a user input has been provided in relation to the virtual object;

a current mode of an artificial reality system in control of the artificial reality environment;

that the virtual object is providing active output; or

any combination thereof.

20. The computing system of claim 18,

wherein one of the multiple display modes includes a key-actions configuration in which certain controls are displayed in relation to the virtual object; and

wherein the certain controls are controls identified as most often used in relation to the type of virtual object corresponding to the virtual object.

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